Multisensor Precipitation Estimator (MPE) Workshop

Richard Fulton
Hydrology Laboratory
Office of Hydrologic Development
National Weather Service
Silver Spring, Maryland

Advanced Hydrologic Applications Course
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Objectives

- Understand the overarching science behind MPE
- Provide hands-on training on how to use MPE software, including 4 lab exercises
- Understand how MPE fits into WFO operations
- Gain your feedback on MPE features

- Note: The Hydroview features of the Hydroview/MPE software application will not be discussed here

What is MPE?

An interactive software tool within the AWIPS WFO Hydrologic Forecast System (WHFS) that:

- Adds value to radar-only rainfall estimates from the WSR-88D ORPG's Precipitation Processing System (PPS)
- Integrates rain gauge and satellite rainfall estimates with the radar-only estimates
- Produces high-resolution gridded rainfall products that are used quantitatively in hydrologic operations at WFOs and RFCs
  - Hydrologic forecast models (Site Specific Hydrologic Model at WFOs; River Forecast System at RFCs)
  - Flash Flood Monitoring and Prediction (future)

Brief History of MPE

- Developed by the NWS Hydrology Lab
- A descendant of “Stage II and Stage III Precipitation Processing” at the RFCs
- S-II and S-III were developed side-by-side with the WSR-88D Precip. Processing System (PPS=Stage I) and integrated with it in late 1980s (pre-NEXRAD)
- S-II and S-III were born about 1990 and were deployed operationally first at ABRFC in Tulsa, OK in early 1990s associated with the NWS AWIPS modernization
- MPE replaced Stage II and III in 2002 at the RFCs with new improved functionality and science
- MPE was adapted and delivered to WFOs within WHFS around 2003
- Enhancement of MPE by the Hydrology Lab to better serve the WFO flash flood program is currently on-going

MPE User Documentation

http://www.nws.noaa.gov/om/whfs/

WHFS Field Support Group: whfs@noaa.gov

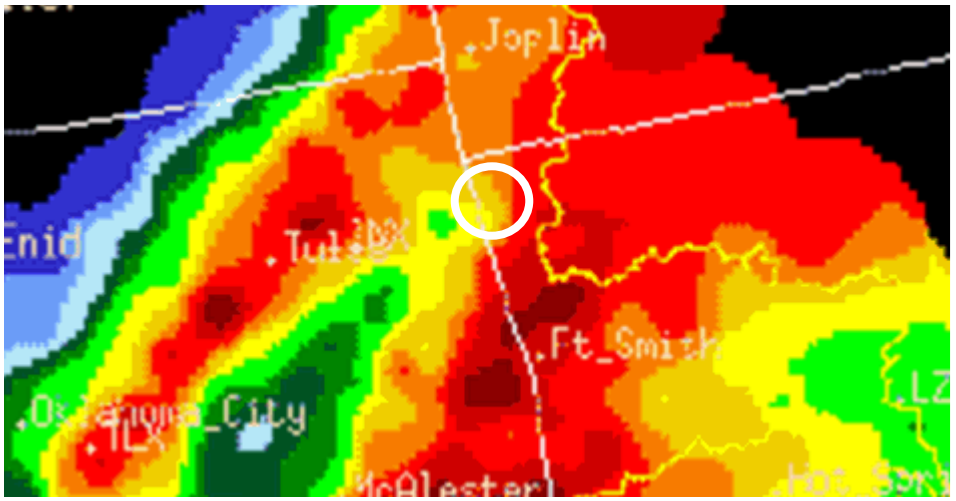
- Hydroview/MPE User's Guide – Build OB5 (2/28/05)
- MPE Field Generation System Document – Build OB4 (3/11/05)
- Hydroview/MPE Implementation Document – OB5 (2/28/05)
- Gage Precipitation Processing Operations Guide (2/28/05)
- Real-time Rain Gauge Quality Controlling
- Radar Climatology Analysis and Display RADCLIM Software Documentation (3/14/05)
- Hydroview documentation
- WHFS Release Notes
- This presentation

Why use MPE?

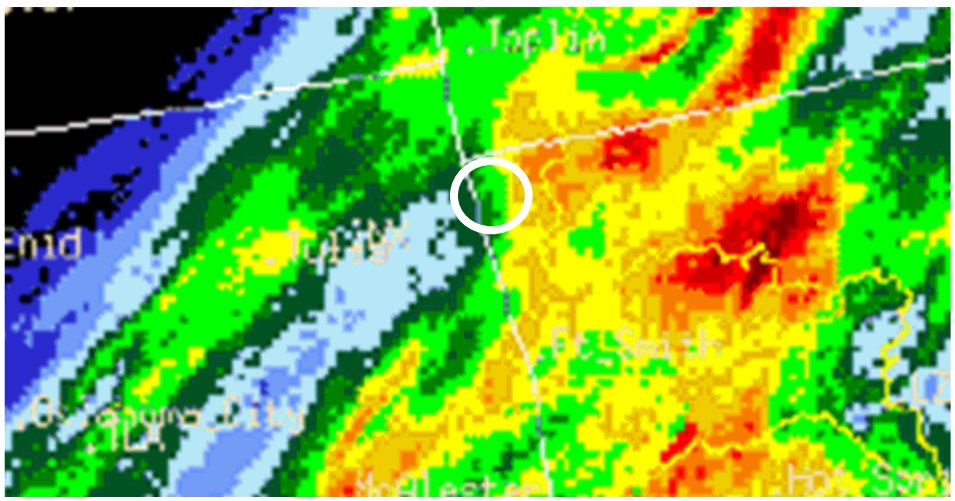
- Radar-only rainfall estimates are plagued with systematic biases that can and must be removed or reduced
- Automated rain gauges and satellites provide independent rainfall estimates to improve radar estimates
- With hydrologic operations and models:
  - Garbage precip. in = garbage streamflow out
  - See example below

MPE Rainfall for Illinois River basin near Watts, OK

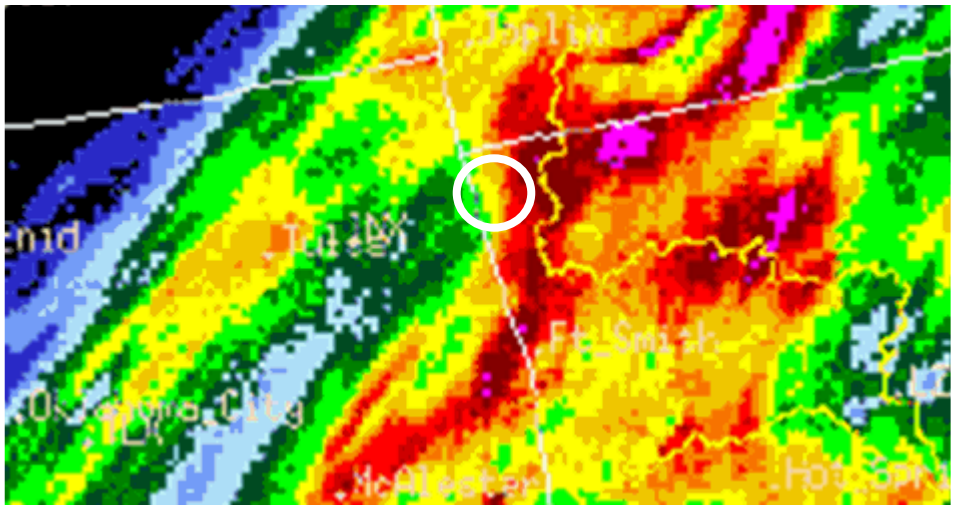
MPE Gauge-only Rainfall (~2.3 in.)



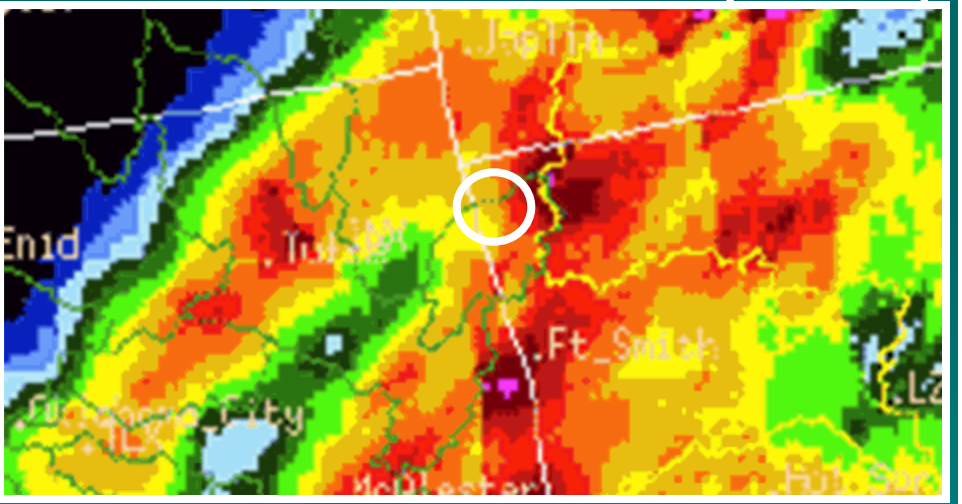
MPE Radar-only Rainfall (~1.0 in.)



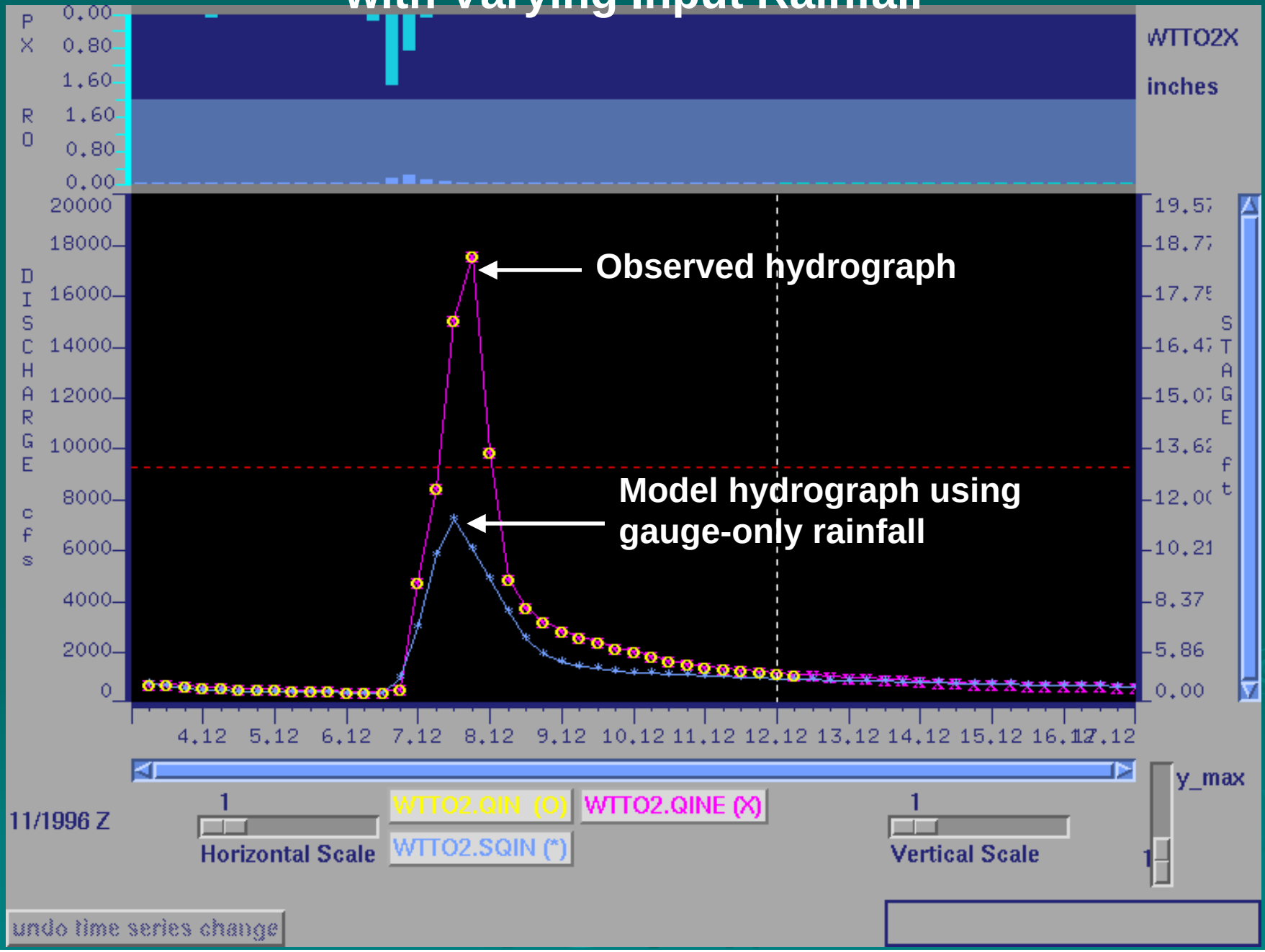
Bias-adjusted Radar Rainfall (~1.7 in.)



MPE Multisensor Rainfall (~2.2 in.)



NWSRFS Lumped Model Hydrographs with Varying Input Rainfall



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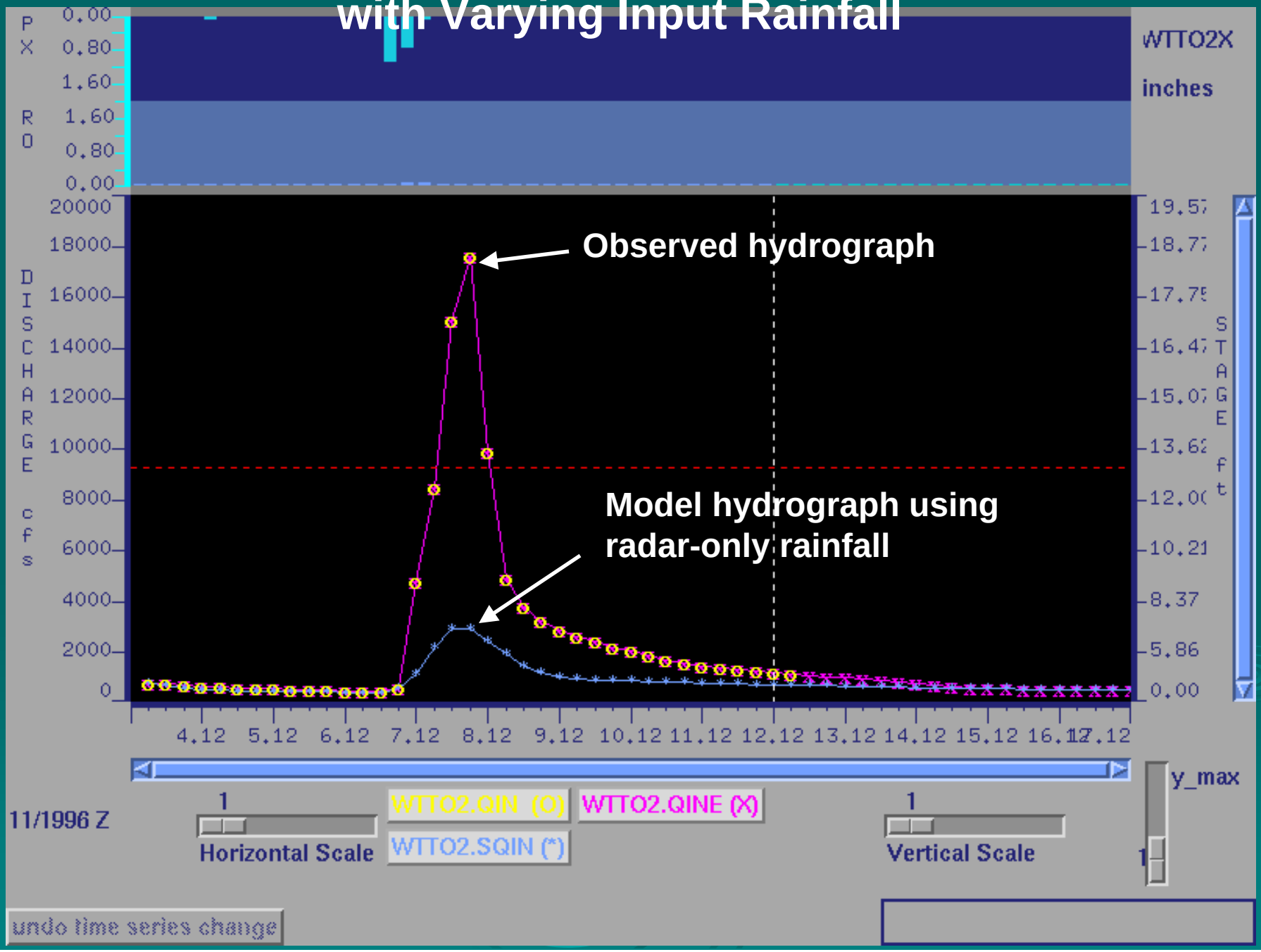

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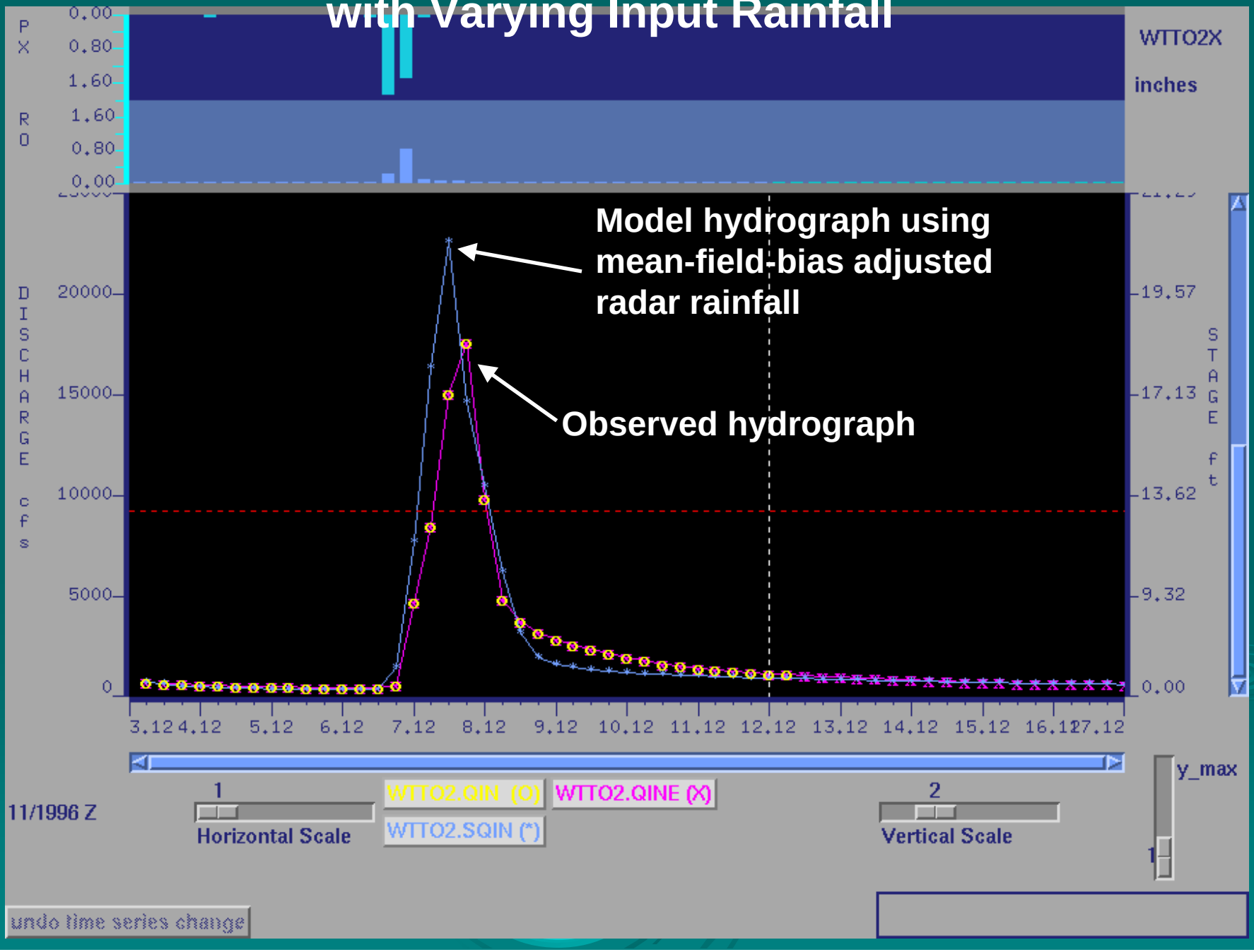

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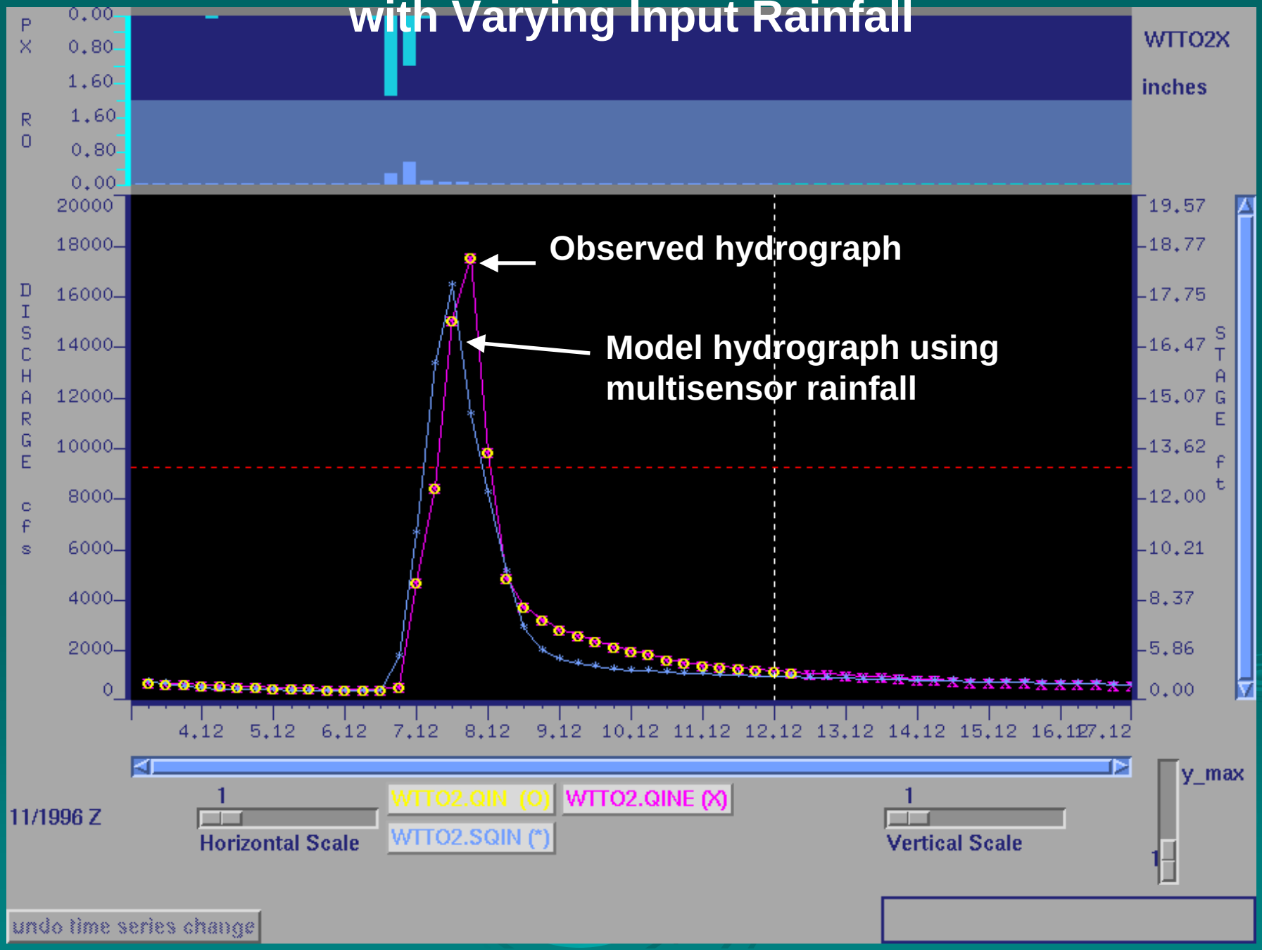


MPE Input Data Sources

- Radar rainfall estimates
  - Digital Precipitation Arrays (DPA…1-hour accumulations) from PPS at top of hour from all WSR-88D/ORPGs covering your forecast/warning area
- Rain gauge rainfall estimates
  - All available automated accumulator (PC) or incremental (PP) gauges
- Satellite rainfall estimates
  - Hourly NESDIS HydroEstimator products at top of hour
- User-defined adaptable parameters and configuration data stored in AWIPS MPE databases
- You…MPE is interactive

Digital Precipitation Array (DPA) Refresher

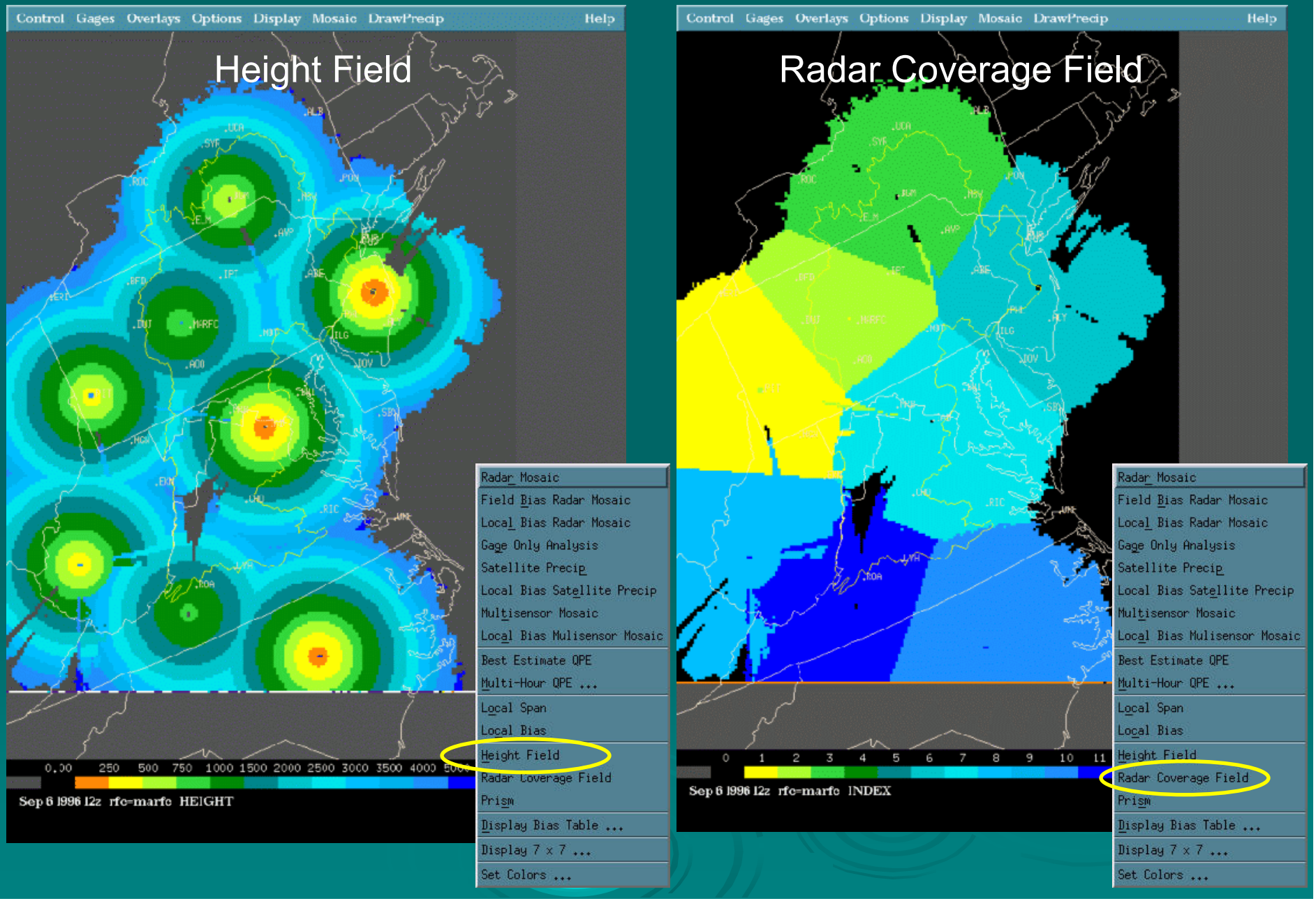
- A one-hour radar-only rainfall accumulation product from the Precipitation Processing System (PPS) on the WSR-88D Open RPG
- A small digital gridded product on a 256-data-level logarithmic rainfall scale from 0-14 inches
- ~4 km grid: Hydrologic Rainfall Analysis Project (HRAP) polar stereographic grid projection
- Produced every volume scan by PPS, but currently MPE only uses the single product at the top of each hour

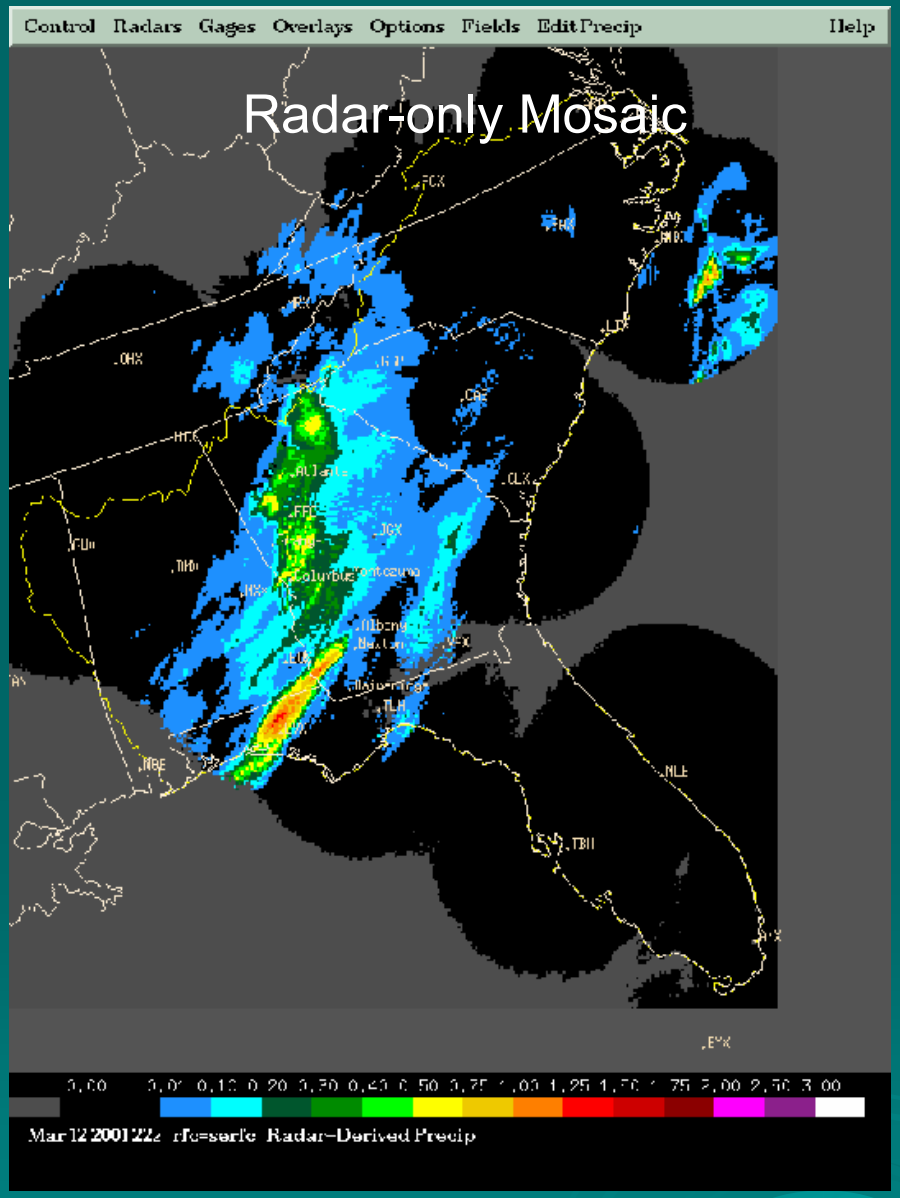
How is MPE Mosaicking Done?

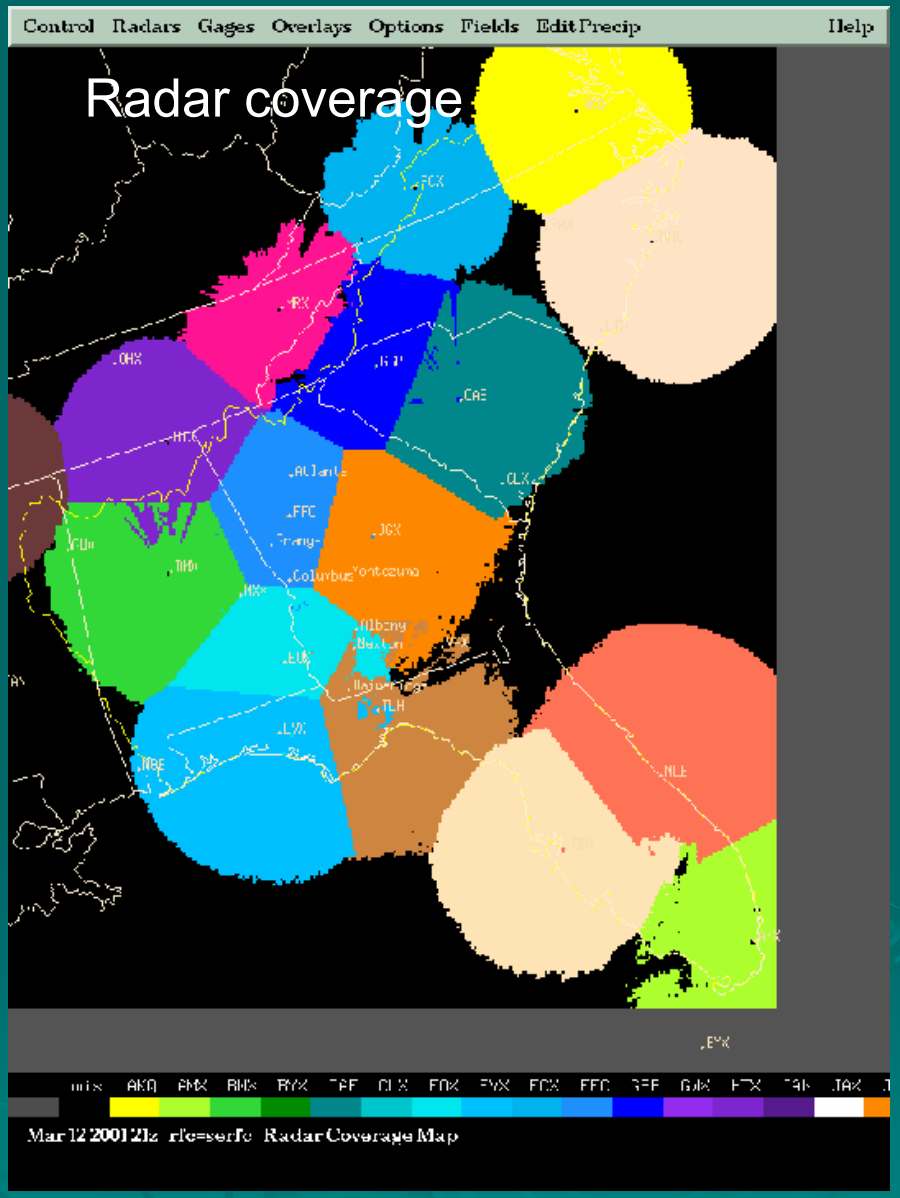
MPE Mosaicking Requirements:

- In overlap areas, use the rainfall from the radar whose pixel is closest to the ground
  - Using mean or maximum exacerbates bright band, range degradation, and beam blockage problems
- Don't use data beyond the "effective coverage" of each radar, i.e.,
  - Don't use radar data at far ranges
  - Don't use terrain-blocked radar data
- If a radar's DPA drops out for one or more hours, then MPE automatically fills in that area with an adjacent radar's gridded data
- Mosaicking can reduce underestimation problems at far ranges plaguing individual radars

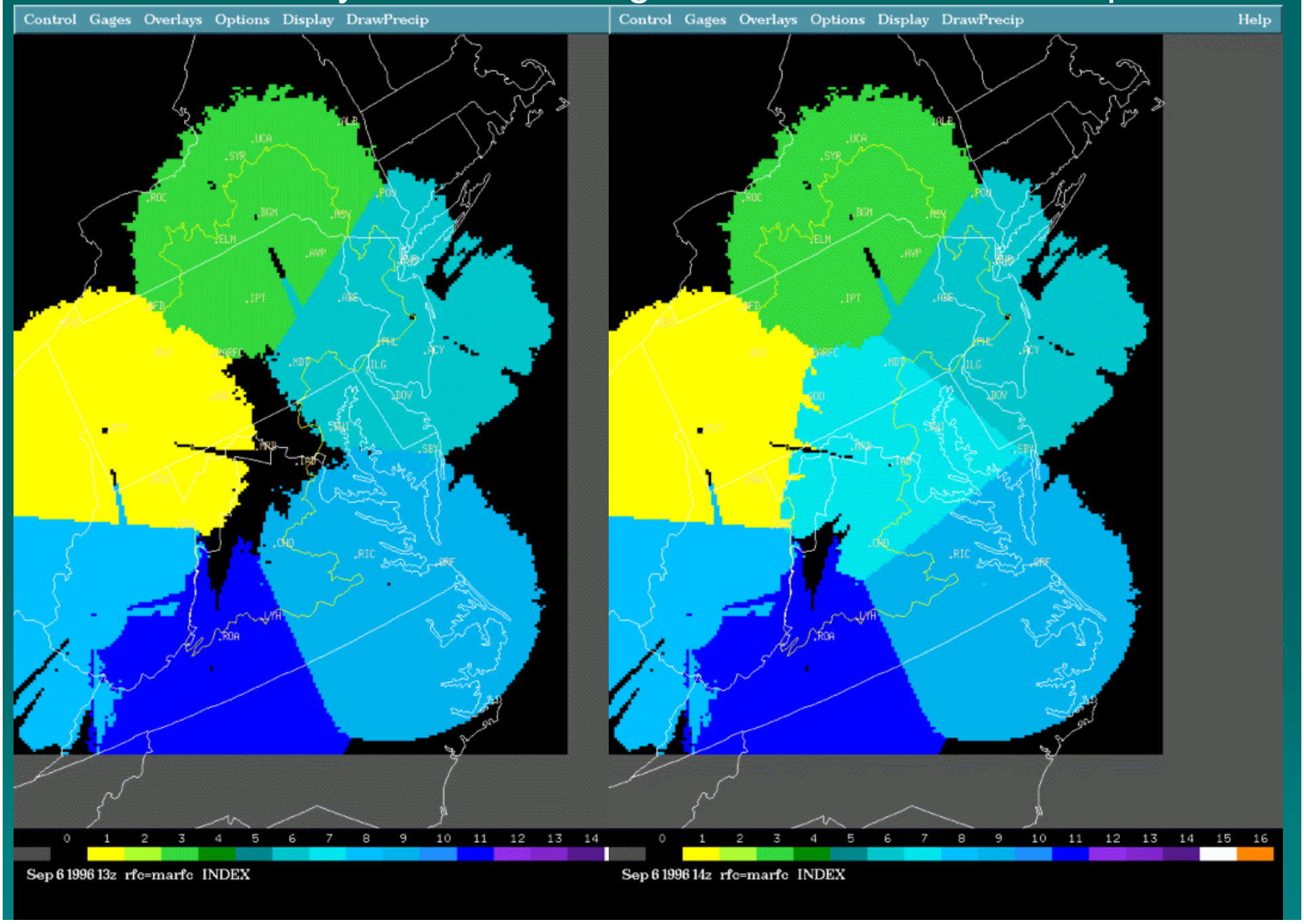
MPE's Mosaicking Technique



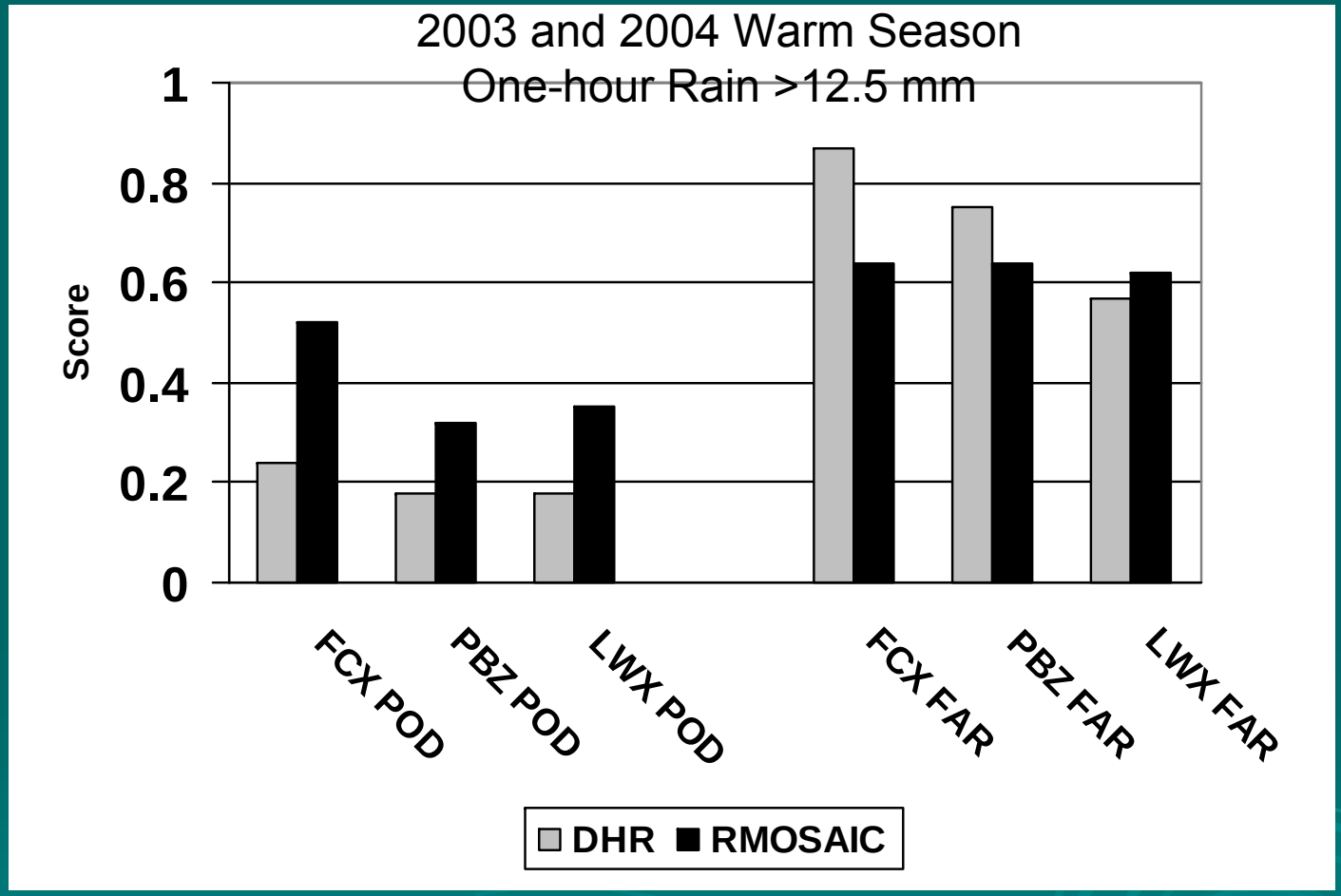

Control Radars Gages Overlays Options Fields Edit Precip Help
Radar-only Mosaic
Mar 12 2001 22z rfc=serfc Radar-Derived Precip


Control Radars Gages Overlays Options Fields Edit Precip Help
Radar coverage
Mar 12 2001 21z rfc=serfc Radar Coverage Map

Automatically Fills in Missing Areas When DPAs Drop out



Mosaicked Radar Detects Rain Far Better than a Single Radar When Compared to Rain Gauges



POD: Probability of Detection FAR: False Alarm Ratio
DHR: Digital Hybrid Scan Reflectivity RMOSAIC: Radar-only MPE Mosaic
FCX: Blacksburg, VA PBZ: Pittsburgh, PA LWX: Sterling, VA

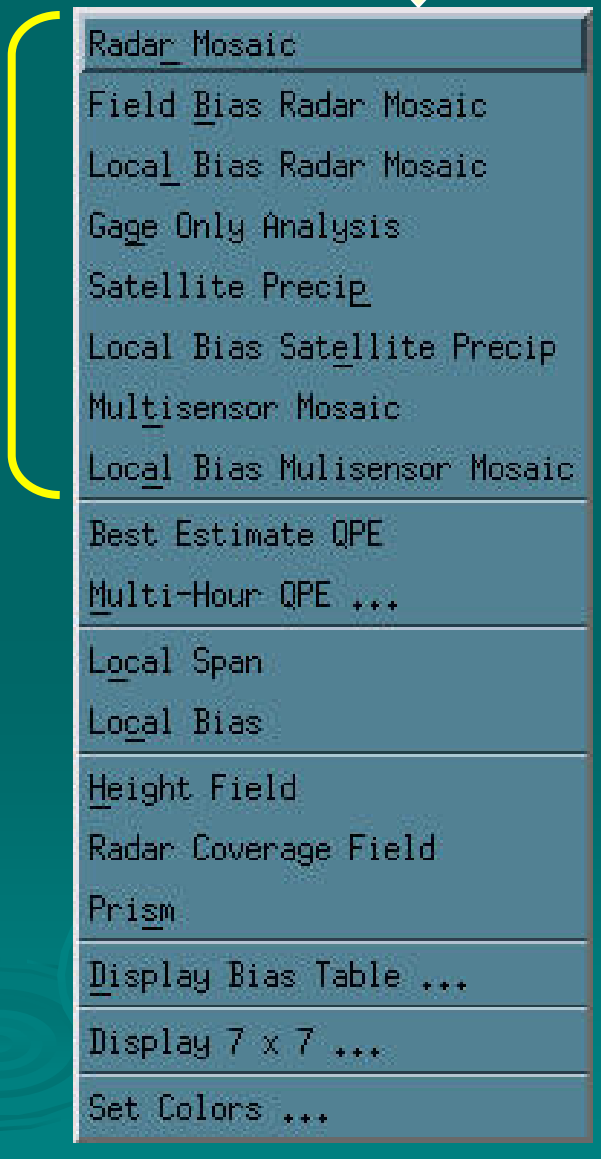
Lab Exercise #1

- Objective: Gain familiarity with the MPE graphical user interface (GUI) using a Hurricane Floyd case study of September 16, 1999

MPE Hourly Rainfall Products

. . . under the “MPEfields” pull-down menu

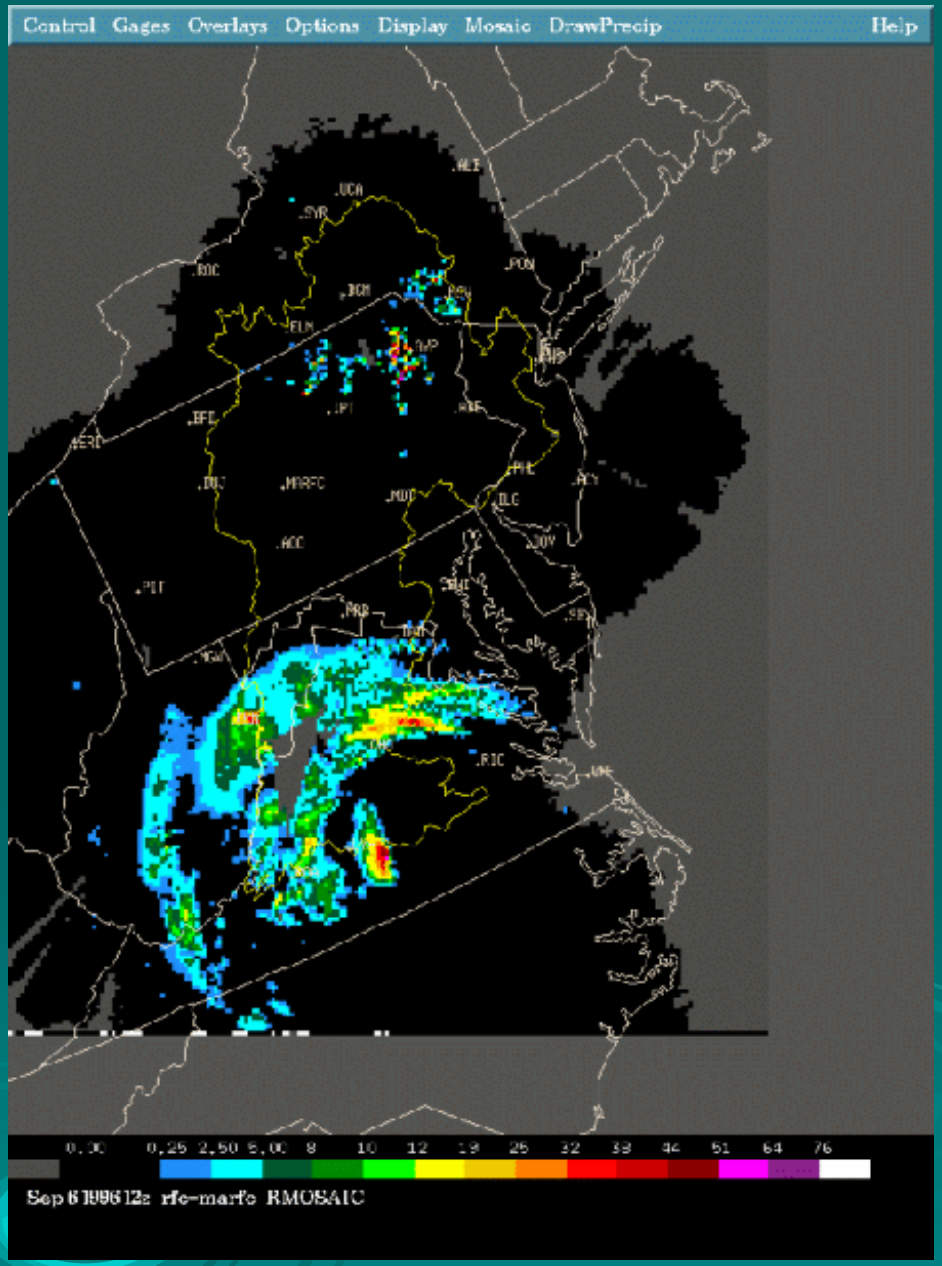
- Radar(-only) mosaic
- (Mean-)field-bias (adjusted) radar mosaic
- Local bias(-adjusted) radar mosaic
- Gauge-only analysis
- Satellite(-only) precipitation
- Local bias(-adjusted) satellite precipitation
- Multisensor mosaic
- Local bias(-adjusted) multisensor mosaic



These products are automatically generated at 25 minutes past every hour.

Radar-only Mosaic (RMOSAIC)

- A simple mosaic of raw DPAs



Mean-field-bias Adjusted Radar Mosaic (BMOSAIC)

- Compute the mean-field-bias (MFB) between hourly gauge and radar rainfall for each radar (MFB=ΣG / Σ R)
  - A single multiplicative ratio that varies from radar to radar and hour to hour such that
    - =1.0 means radar matches gauges on average
    - >1.0 means radar is underestimating on average
    - <1.0 means radar is overestimating on average
  - Note: adjusting radar using MFB has exactly the same effect as altering the "A" parameter in $Z=A R^b$
- Multiply MFB X DPA for each radar
- Mosaic these products together

DPAs + Point Rain Gauges

=

BMOSAIC

Computing Mean-Field-Bias

- Use only raining gauge-radar pairs (G>0 and R>0)
- Select only G-R pairs within the “effective radar coverage” of each radar
- Use at least a minimum threshold number of hourly gauge-radar pairs per radar (adaptable parameter…10 is default)
  - If <10 in current hour, go back in time long enough to accumulate at least 10 raining pairs
- Gauge-radar bias table stores this information for each radar

Gauge-Radar Bias Table

Compute biases once an hour for many different memory spans ranging from short-term (1-hr) to long-term (months)

BUF

CLOSE HELP Sep 16 1999 22z

NPairs Threshold = 10

Memory Span (hrs)	NPairs	Mean Gage (mm/hrs)	Mean Radar (mm/hrs)	Bias
0.001	3.00	3.22	0.60	5.40
1.000	6.30	3.42	0.97	3.52
2.000	12.08	3.48	1.07	3.26
3.000	18.33	3.51	1.09	3.23
5.000	29.07	3.54	1.10	3.23
10.000	44.88	3.55	1.10	3.24
168.000	72.61	3.54	1.09	3.25
720.000	85.60	3.54	1.38	2.57
2160.000	242.53	3.75	2.55	1.47
10000000.000	1306.38	3.72	3.03	1.23

1 week →

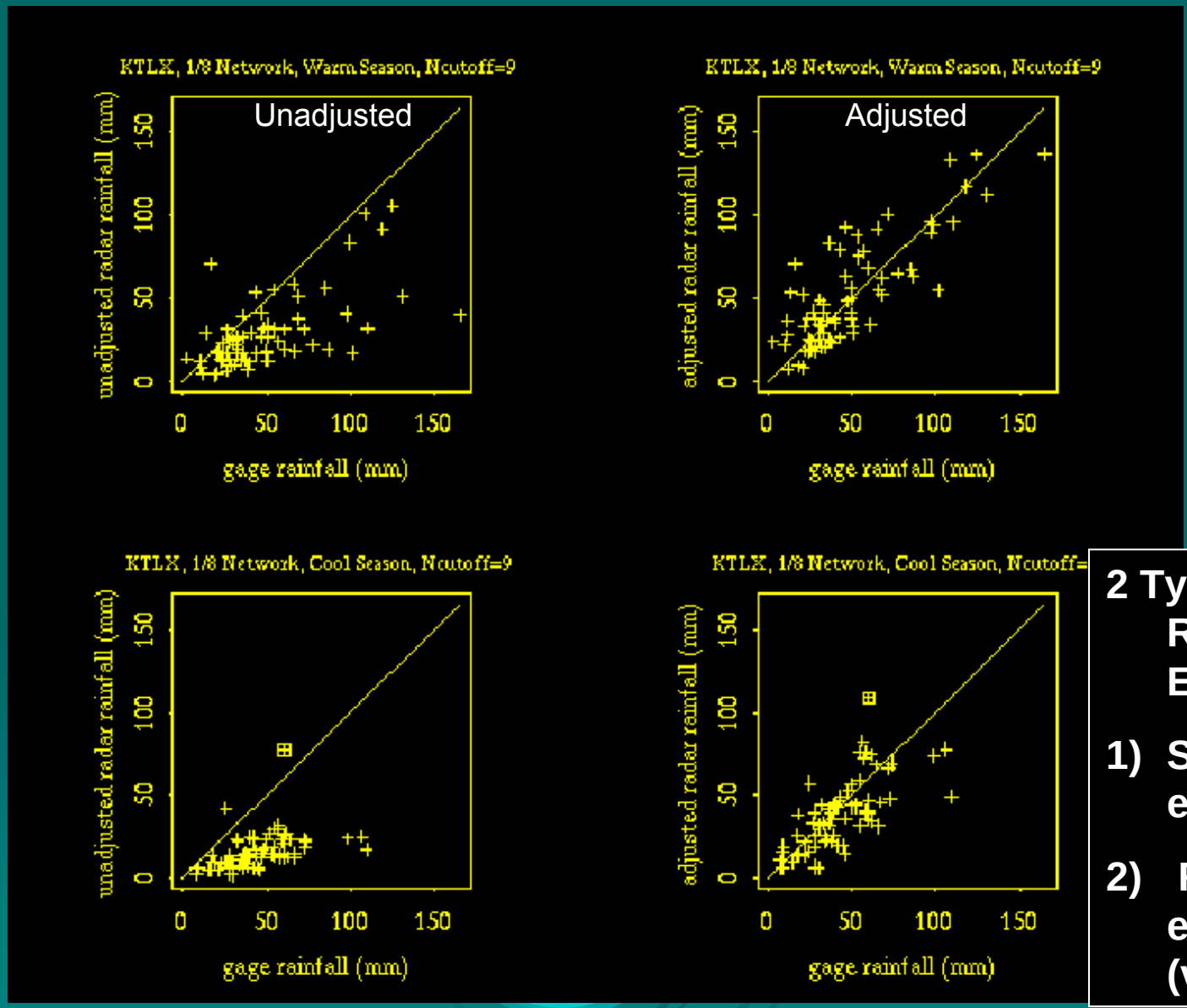
3 months →

Located under MPEfields, *Display Bias Table* menu, then click on a radar ID

Effects of Mean-field-bias Adjustment

Warm season

Cold season



2 Types of Rainfall Errors:

1) **Systematic errors (bias)**
2) **Random errors (variance)**